

Insights into the Behavior of Potential Structural Failures Originating from Localized High Stress Regions in Configurations Relevant to Solid Rocket Motor Nozzles

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During the structural certification effort for the Space Launch System solid rocket booster nozzle, it was identified that no consistent method for addressing local negative margins of safety in non-metallic materials had been developed. Relevant areas included bond-line terminations and geometric features in the composite nozzle liners. In order to gain understanding, analog test specimens were designed that very closely mimic the conditions in the actual full scale hardware. Different locations in the nozzle were represented by different analog specimen designs. This paper describes those tests and corresponding results. Finite element analysis results for the tests are presented. Strain gage correlation of the analysis to the test results is addressed. Furthermore, finite fracture mechanics (a coupled stress and energy failure criterion) is utilized to predict the observed crack pop-in loads for the different configurations. The finite fracture mechanics predictions are found to be within a 10% error relative to the average measured pop-in load for each of four configurations. Initiation locations, arrest behaviors, and resistances to further post-arrest crack propagation are also discussed.